3 Instructions for Relative Risk Site Evaluations

This section provides a set of general and specific instructions for conducting relative risk site evaluations at installations and formerly used defense sites (FUDS). The general instructions in Section 3.1 apply throughout the evaluation. Instructions on performing medium-specific evaluations and completing specific parts of the Relative Risk Site Evaluation Worksheet follow in Sections 3.2 through 3.6. Because it forms the basis of so much of the evaluation, the CHF, as it applies to all media, is discussed in detail. Following that, instructions for evaluating each medium are given, with specific instructions for each of the factors in that medium.

3.1 General Instructions

Use the Relative Risk Site Evaluation Worksheet, in Appendix A (or its electronic equivalent), to record pertinent information on the site being evaluated. Page 1 of the Worksheet asks for information on the site. Pages 2 through 7 ask for information on each environmental medium (groundwater, surface water [human and ecological endpoints], sediment [human and ecological endpoints], and soil) and cover determinations of the CHF, MPF, and RF for each medium.

Proceed through the Worksheet using the specific instructions in this Primer. Evaluate all media with reliable analytical data at all sites; designate those sites without reliable analytical data as "Not Evaluated." See Figure 3 for an illustration of this decision logic.

Use the most recent yet representative sampling and analysis data from existing restoration documents or databases to complete the Worksheet; additional data gathering activities are not required. Examples of such documents include completed site inspections, remedial investigations, feasibility studies, engineering evaluations/cost analysis studies, records of decision, decision documents, design documents, performance monitoring reports, and equivalent types of information.

When conducting relative risk site evaluations for sites contaminated solely with petroleum, oils, and lubricants (POL), do not use Total Petroleum Hydrocarbon data. Instead, use the concentrations for benzene, toluene, ethylbenzene, and xylene (BTEX) compounds in each medium, together with corresponding BTEX standards, to calculate the CHF. Support for using BTEX compounds in the evaluation of POL contamination can be found in *Use of Risk Based Standards for Cleanup of Petroleum Contaminated Soil* (Department of the Air Force, June 1994).

When conducting relative risk site evaluations for sites contaminated with POL ***and*** other contaminants, use the concentrations for BTEX compounds and the other contaminants present, together with their corresponding comparison values, to calculate the CHF.

Do not perform relative risk site evaluations at sites that are categorized as either "response complete" (RC) or "all remedies in place" (RIP). See Sections 1.4 and 4 for these definitions. Do not perform relative risk site evaluations on sites without reliable concentration data. These sites should be categorized as Not Evaluated (NE). Finally, do not perform relative risk site evaluations on PRP sites and sites comprised solely of ordnance.

3.2 Site Information

The first page of the Worksheet asks for information on the background of the site and a summary of key elements of information about the site.

Site Background Information. Provide a record of basic information on the following: the installation's name (property name for FUDS), location, site name (project name for FUDS), and Restoration Management Information System (RMIS)/Defense Site Environmental Restoration Tracking System (DSERTS) identification number (project number for FUDS), contact person, date of relative risk site evaluation, media evaluated, site execution phase from which data are available (e.g., site inspection, remedial investigation, remedial design), agreement status of the site, and site type. Applicable regulatory agreements and their codes and a list of site types are found in Appendix C. Much of this information is available from existing DoD Component databases and is typically imported from these into appropriate data fields for each site. For example, agreement status and site type codes are available in and obtained from RMIS/DSERTS.

The background information will aid in understanding the quality of information used in site evaluations, the level of uncertainty associated with the data, and anticipated follow-on phases of execution. It will also assist in explaining activities at the site to stakeholders.

Site Summary ("Project Summary" for FUDS). Briefly describe the source of contamination (materials disposed of) at the site, the exposure setting (the site's physical environment), and any potentially exposed human and ecological receptors. The emphasis should be on including the key elements of information used to conduct the relative risk site evaluation. As noted on the summary sheet, you may include a map and/or cross section of the site.

Preparers of worksheets should also determine their Component-specific procedures for submitting relative risk site evaluation documentation.

3.3 Evaluation of Contaminant Hazard Factor

This subsection discusses the general method, common to all environmental media, for evaluating the CHF. The CHF will be *significant*, *moderate,* or *minimal,* based on summing the ratios of maximum contaminant concentrations in each medium to corresponding comparison values in Appendices B-1, B-2, or B-3, as appropriate. The CHF is *significant* for a medium when the sum of the ratios for that medium exceeds 100, *moderate* when the sum of the ratios is from 2 to 100, and *minimal* when the sum of the ratios is less than 2. (See Figures 8 and 9.)

Select contaminants for inclusion in the CHF evaluation for each medium and list them on the Worksheet. **Only chemicals listed in the appropriate Appendix (B-1, B-2, or B-3) can be included.** Total Petroleum Hydrocarbons (TPH) is not included, and only specific petroleum constituents are listed. **Select only those contaminants having reliable analytical data, using the most recent yet representative sampling and analysis data.** General considerations for selecting contaminants are discussed at the end of this subsection, while considerations specific to each medium are discussed under the specific instructions for the medium. If no reliable concentration data are available for any contaminants for the medium, no evaluation can be made of that medium, and the medium should be rated as "Not Evaluated." If sampling results for a particular medium are below detection limits or are detected within established background

Contaminants		Calculation*****	Rating
Carcinogen A:	$[A]^{*}_{max}$		
Carcinogen B:	$[B]_{max}$	$\frac{[A]^{*}_{max}}{Std^{**}} + \frac{[B]_{max}}{Std^{**}} + \frac{[C]_{max}}{Std^{***}} = X_1$	>100 = Significant CHF
Non-carcinogen C:	$[C]_{max}$		2-100 = Moderate CHF
			<2 = Minimal CHF
Ecological D:	$[D]_{max}$	$\frac{[D]_{max}}{Std^{****}} = X_2$	

[A]* - Maximum concentration in medium
Std** - Comparison value based on 10^{-4} human cancer incidence
Std*** - Comparison value based on reference dose for humans
Std**** - Comparison value for ecological receptors where available

*****Use comparison values in Appendix B-1, B-2, or B-3, as appropriate

Note: Contaminants posing a threat to ecological receptors (i.e., ecological contaminants) must be evaluated separately from those posing a threat to human receptors

Figure 8. Mechanics of the Contaminant Hazard Factor Calculation

Contaminants		Calculation*****		Rating
Carcinogen A:	$[A]^*_{max}$	$\frac{[A]^*_{max}}{Std^{**}} + \frac{[B]_{max}}{Std^{**}} + \frac{[C]_{max}}{Std^{***}} + \frac{[E]_{max}}{Std^{**}} + \frac{[E]_{max}}{Std^{***}}$	$= X_1$	
Carcinogen B:	$[B]_{max}$			>100 = Significant CHF
Non-carcinogen C:	$[C]_{max}$			2-100 = Moderate CHF
Carcinogen/ Non-carcinogen E:	$[E]_{max}$			<2 = Minimal CHF
Ecological D:	$[D]_{max}$	$\frac{[D]_{max}}{Std^{****}}$	$= X_2$	

[A]* - Maximum concentration in medium
Std** - Comparison value based on 10^{-4} human cancer incidence
Std*** - Comparison value based on reference dose for humans
Std**** - Comparison value for ecological receptors where available

*****Use comparison values in Appendix B-1, B-2, or B-3, as appropriate

Note: Contaminants posing a threat to ecological receptors (i.e., ecological contaminants) must be evaluated separately from those posing a threat to human receptors

Figure 9. Mechanics of the Contaminant Hazard Factor Calculation for Substances with both Carcinogenic and Non-Carcinogenic Effects

concentration ranges, then that medium should automatically be assigned a rating of *Low*. If sampling results for each and every medium sampled are below detection or are within established background concentration ranges, the site is automatically assigned a category of *Low* (see Figure 3).

For each contaminant listed on the Worksheet, record the most recent yet representative maximum detected concentration of that contaminant in that medium at that site on the Worksheet. Adjacent to this value record the appropriate comparison value for the contaminant from Appendix B-1, B-2, or B-3. (See the instructions for each medium for the comparison values appropriate to that medium.) Calculate the ratio to be listed on the Worksheet by dividing the maximum concentration by the comparison value. Select only those contaminants having reliable analytical data, using the most recent sampling and analysis data **which is representative of the site**.

Sum the column of ratio values to obtain the total value (Figures 8 and 9). Where a lengthy series of analyses has been carried out, it is not necessary to list every contaminant found. However, **the Worksheet should include all contaminants of concern that are attributable to the site**, especially those that produce the highest ratios of observed concentrations to their comparison values. The highest ratios do not necessarily result from contaminants with the highest concentrations. Extremely carcinogenic or toxic compounds may have very low comparison values and therefore result in the highest ratios.

The existence of high ratio values will lead to a higher rating for the CHF. Note that the CHF is *significant* when the sum of the ratios exceeds 100. Every attempt should be made to include all contaminants of concern present at a site for the CHF calculation in order to be able to compare current site evaluations with future ones.

In selecting contaminants with reliable analytical data, review the contaminants that have been detected in the medium and that can be reasonably attributed to the site. Attribution implies that the contaminant concentrations are distinguishable from background concentrations. **Do not include naturally occurring compounds that are detected within established background concentration ranges.** Additionally, if all analytical data are within established background ranges for a medium or site, automatically assign that medium or site a rating of *Low*. All contaminants that have been reliably reported at concentrations near or above the detection limit can be included.

For contaminants with reliable analytical data, record only the maximum concentration found in the medium for each contaminant. The contaminants need not have been detected at the same location, but contaminant data should be recent and representative of conditions at the site. Additional considerations specific to each medium are discussed in the instructions for that medium.

To implement the requirements of this section (use reliable data, do no use results that are less than detection limits, do no use results within background ranges) media with CHF values below 0.005 will be assigned a category of *Low*.

3.4 Evaluation of Groundwater

The evaluation of the groundwater medium is summarized in Figure 4. Groundwater contaminant data used in site evaluations must be based on groundwater samples affected by the site. The sampling location need not be on installation property, but contamination must be attributable to the site. The groundwater sample location (i.e., a well) may be a source of drinking water or irrigation water, or it may be a monitoring well. A well that is confirmed to be upgradient from the site **does not** provide suitable data for this evaluation.

If a well is thought to be influenced by more than one site, exercise additional care in selecting the data to be used. Select only contaminants that can reasonably be linked to past practices at the site. If, for example, a site was contaminated by trichloroethylene (TCE) and an adjacent site had been shown to have chromium contamination, even though both TCE and chromium may appear in groundwater samples downgradient from the sites, restrict the evaluation of each site solely to the specific contaminants that can be reasonably linked to the site. Depending on past practices, this could be both the TCE and chromium or just the chromium or just the TCE.

Contaminant Hazard Factor (CHF). Review the most recent yet representative analytical data to determine what contaminants have been detected in groundwater at or near the site and which of these contaminants can be reasonably attributed to the site. Attribution implies that the contaminant concentrations are distinguishable from background concentrations. For metals, analyses are often available for both the dissolved fraction and the "total" concentration. The dissolved data are preferred for this evaluation and should be used if available.

For each contaminant listed on the Worksheet, note a maximum detected concentration in ug/l. Adjacent to this value, record the comparison value for the contaminant, using the values in Appendix B-l. For groundwater use the value listed under "water," which is reported in units of ug/l.

Migration Pathway Factor (MPF). The migration of a contaminant from a site into and through groundwater is dependent upon a complex interaction of the physical and chemical properties of the contaminant, the hydrologic environment surrounding the site, and the presence or absence of physical factors that could impede transport. The likelihood of transport of contaminants via groundwater is evaluated qualitatively as *evident, potential*, or *confined* (see Figure 4), based on available information for a site and professional judgment.

The MPF is evaluated as *evident* only if analytical data or direct observation indicates that contamination in the groundwater is moving or has moved away from the area under the source. The data used in this evaluation may be from a water supply well or monitoring well (see Figure 10 for illustrations).

The MPF is *potential* under the following conditions:

- Contamination in the groundwater is largely restricted to the area directly under the source or only slightly beyond the edge of the source (i.e., tens of feet)
- There is no evidence of appreciable contaminant migration in groundwater, but subsurface soil contamination has been identified, the contaminants have physical properties that suggest they are mobile, and there are no known barriers to migration. A leaking underground storage tank above the water table is an example.
- Information is not available to support an MPF of *evident* or *confined*.

The MPF is *confined* at sites where the contaminants in the source have very little potential to migrate to groundwater, or where contaminated groundwater has little potential to be transported down-gradient. Confined conditions may be due to physical barriers to migration, such as a hydraulic barrier created by an installed and properly operating removal or remedial action, or a confining clay layer between the source and groundwater. There may be limited net precipitation (i.e., 0 to 5 inches per year) to

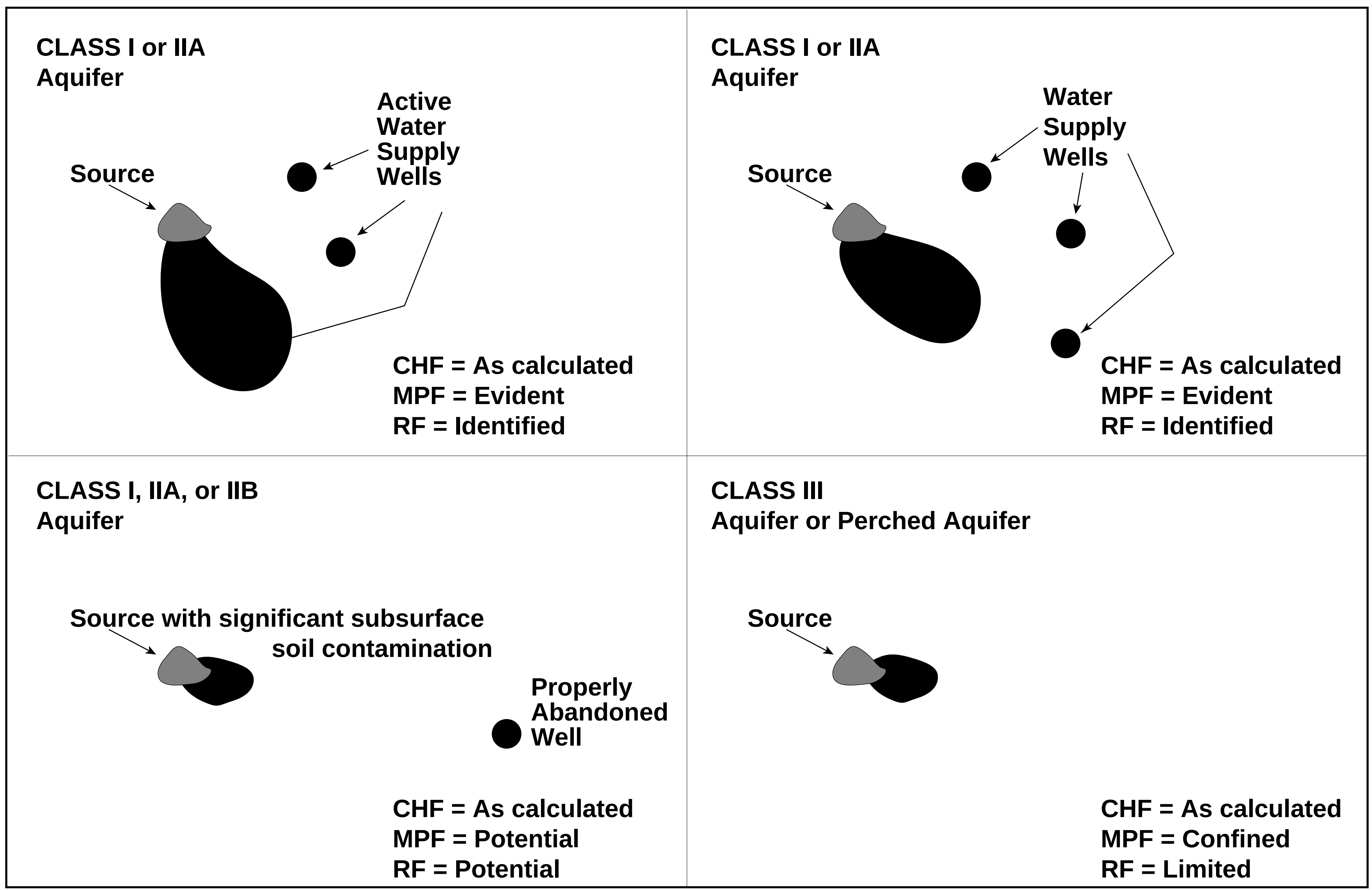

Figure 10. Example Scenarios for the Groundwater Medium

drive soil contamination towards groundwater, and/or groundwater may be located several hundred feet below the ground surface with very long travel times for contamination to reach groundwater.

Receptor Factor (RF). Possible RFs are *identified, potential,* and *limited* (see Figure 4). Only human receptors are considered for groundwater exposure, and no distinction is made for the type of receptor (e.g., workers versus residents) or the number of receptors.

Evaluate the RF as *identified* if a currently used water supply well downgradient from the source is threatened. A threatened water supply well is one that is impacted by contamination, or will likely be impacted by contamination within a reasonable timeframe. The water supply must be equivalent to either EPA Class I or Class IIA groundwater, as outlined in Table 1. The RF is *potential* if there are no threatened water supply wells downgradient from the source, but the groundwater is currently or potentially usable for drinking water, irrigation, or agriculture. The water supply should be equivalent to EPA Class I, Class IIA, or Class IIB groundwater (Table 1). The RF is *limited* when there is no potentially threatened groundwater supply well downgradient from the source and the groundwater is not considered to be a potential source of drinking water and is of limited beneficial use. This is a water supply equivalent to Class III groundwater (Table 1), such as saline water or an aquifer with insufficient production to meet the needs of an average household, for example, a perched aquifer (see Figure 10). Do not include properly abandoned wells in the RF evaluation.

3.5 Evaluation of Surface Water and Sediment

The evaluations for the surface water and sediment media are summarized in Figure 5. Consult a topographic map that includes the site under evaluation when evaluating surface water and sediment factors. A topographic map will reveal surface water features that potentially can be affected by the site and will provide a view of potential migration pathways toward surface water receptors. Either water or sediment samples can be used to document the presence and migration of contaminants (and in some cases receptors) for this evaluation.

Contaminant Hazard Factor (CHF). For contaminants in surface water with a potential for human exposure, use comparison values in Appendix B-1 under "water," which are reported in units of ug/l. For contaminants in surface water with a potential for ecological exposure, use comparison values in Appendix B-2, which are reported in units of ug/l. For contaminants in sediment with a potential for human exposure, use values in Appendix B-1 under the "soil" column, which are reported in units of mg/kg. For contaminants in sediments with a potential for ecological exposure, use comparison values in Appendix B-3, which are reported in units of mg/kg. Only contaminants with comparison values in the appropriate tables are to be included in the CHF calculation. A *significant* CHF is greater than 100. A *moderate* CHF is from 2 to 100. A *minimal* CHF is less than 2. (See Figures 8 and 9.)

Review the most recent yet representative analytical data to determine what contaminants have been detected in surface water and sediment at or near the site and which of these contaminants can be reasonably attributed to the site. Attribution implies that the contaminant concentrations are distinguishable from background concentrations. Samples collected from surface streams, drainage ditches, rivers, lakes, wetlands, and embayments are all appropriate. Samples do not have to be collected adjacent to the site, but greater distances often make attribution to the site more difficult, and dilution from downstream tributaries often reduces observed contaminant concentrations.

For metals in surface water samples, analyses are often available for both the dissolved fraction and the "total" concentration. If they are available, use the data on the dissolved fraction.

Sediment is the result of deposition of solid material from the water. Obtain sediment samples from surface water bodies receiving runoff from the site or from areas such as swales and ditches that are known to have transported water from the site.

For each contaminant listed on the Worksheet, note a maximum detected concentration. Use units of ug/l for water samples and mg/kg for sediment samples. Adjacent to this value record the comparison value for the contaminant using the appropriate subsection of Appendix B.

Migration Pathway Factor (MPF). The likelihood of transport of contaminants via surface water or sediment is evaluated qualitatively as *evident*, *potential*, or *confined* (see Figure 5). Base MPF evaluations on available information and professional judgment. The MPF is *evident* if analytical data or direct observation indicates that contaminants in surface water and sediments are present at a point of exposure for a surface water receptor or have moved in surface water or sediments away from the source towards a point of exposure for a surface water receptor. Water or sediment samples can provide the analytical data. Showing the actual movement of contaminated runoff from a source toward a point of exposure is needed for direct observation (see Figure 11).

The MPF is *potential* in any instance where there is information to suggest contamination could move away from the source toward a point of exposure for a surface water receptor, or has moved slightly beyond the source area (i.e., tens of feet). Where there is insufficient information to support an MPF of *evident* or *confined*, the MPF defaults to *potential*.

Application of the *confined* MPF to a site requires information that transport of contaminants from the source by surface water to a potential point of exposure to a surface water receptor is restricted. Reasons to believe such a condition could exist include the following:

- The site has engineered runon/runoff controls that can effectively interrupt transport of contaminants to surface water.
- Removal or remedial actions have been implemented that restrict the movement of contaminants away from the source.
- The contamination at the source is below the ground surface and is not subject to erosion or interaction with surface water. For example, leaking underground storage tanks may result in subsurface soil and groundwater contamination but not contamination of surface water.
- Topographic conditions prevent surface water from leaving the immediate area of the site. If there is effectively no runoff from the site to surface water, there will be no migration of contaminants to points of exposure. This may also occur in areas with very low rainfall, perhaps with only nearby ephemeral streams. In some areas surface water may be completely lost to groundwater recharge.

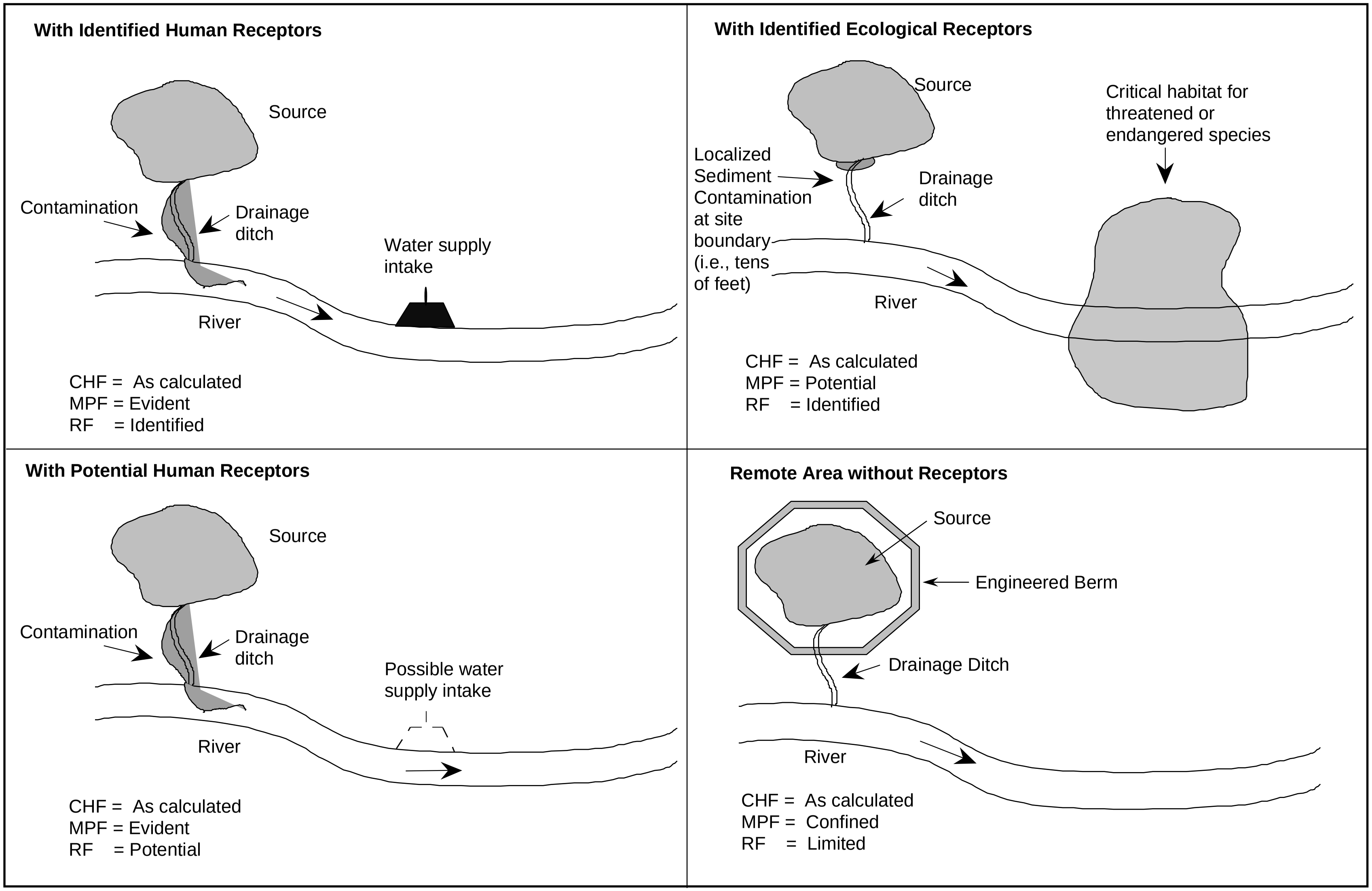

Figure 11. Example Scenarios for the Surface Water and Sediment Media

Note that the rationale for a *confined* MPF must be based upon hydrologic factors; water must be prevented from coming into contact with contaminated sources or moving to a potential point of exposure for a surface water receptor. The chemical or physical characteristics of the contaminants, although important in determining transport mechanisms, will not in themselves prevent such transport. The chemical and physical properties of a contaminant may determine whether it will be transported primarily in a dissolved form or adsorbed on particulate matter, but if the contaminant is in contact with surface water and subject to erosive forces, it will tend to move. Further, the existence of manmade structures, such as dams, or the presence of lakes and reservoirs in the surface water pathway does not necessarily imply a *confined* condition. Although the travel time for the contaminants will undoubtedly be affected by such structures, the migration pathway may still be uninterrupted.

Receptor Factor (RF). Receptors could be subject to a number of exposure scenarios associated with surface water and sediment. Surface water can be a source of drinking water and is often used for recreational activities such as boating, swimming, and fishing. Human exposure could occur through the use of surface water for drinking water, the incidental ingestion of surface water during recreational activity, dermal contact with surface water or sediments, ingestion of aquatic species caught in the water body for human consumption, and the use of surface water for watering livestock or irrigation of human food crops. Aquatic species, considered part of the human food chain, could potentially include fresh and marine species, such as finfish, shellfish, shrimp, squid, snails, and crayfish. Ecological receptors to be considered are restricted to those areas specifically identified in Table 2.

The RF can be *identified*, *potential*, or *limited* (see Figure 5). Rate the RF as *identified* whenever receptors have been specifically identified as having access to surface water or sediment to which the contaminants have moved or can move. This could potentially include the use of water as drinking water, for irrigating human food crops, for watering livestock, and for supporting recreational activity, including fishing. It could also include the presence of ecological areas downstream from the site and within the surface water migration pathway (see Figure 11).

The RF is *potential* if there are no known uses of surface water as outlined above, but the potential for such use is thought to exist because of nearby populations or predicted future development.

The RF is *limited* when it is unlikely that human population will come into contact with the water or sediment and when there are no ecological receptors apparent. These conditions, as they apply to humans, may be met in remote areas or areas in which access is highly restricted.

3.6 Evaluation of Surface Soils

Samples for the soil evaluation should be from a depth of 0 to 6 inches. If samples are not available from this interval, samples from depths up to 24 inches can be used. Preference is given to shallower samples when there is a choice. In no instance should samples deeper than 24 inches be used. For the purpose of this evaluation, the hazard posed by subsurface soil contaminants (e.g., a buried leaking storage tank deeper than 24 inches) is assumed to be assessed by the evaluation of groundwater (based on actual groundwater sampling data), which would be the most probable pathway of deep soil contaminant migration to humans.

Contaminant Hazard Factor (CHF). For contaminants in surface soils with a potential for human exposure, use comparison values in Appendix B-1 under "soil," which are reported in units of mg/kg. Contaminants in soils with a potential for ecological exposure are not evaluated since comparison values for such contaminants do not currently exist. A *significant* CHF is greater than 100. A *moderate* CHF is from 2 to 100. A *minimal* CHF is less than 2 (see Figures 8 and 9).

Review the most recent yet representative analytical data to determine what contaminants have been detected in surface soils at the site. Attribution of the contaminants to the site requires that the observed concentrations are distinguishable from background.

For each contaminant listed on the Worksheet, note a maximum detected concentration in mg/kg (ppm). Adjacent to this value, record the comparison value for the contaminant, using the values in Appendix B-1.

Migration Pathway Factor (MPF). The likelihood of transport of contaminants through soil is evaluated qualitatively as *evident*, *potential*, or *confined* (see Figure 6 for definitions). Base MPF evaluations on available information and professional judgment. Assign *evident* to the MPF if analytical data or direct observation indicates that contamination is present at, is moving toward, or has moved to a point of exposure. This may be determined through analysis of runoff or observation of secondary sources as a result of the slumping of soil or wind erosion.

Assign *potential* to the MPF if contamination has moved only slightly beyond the source (i.e., tens of feet) or it could move but is not moving appreciably. Where there is insufficient information to support an MPF of *evident* or *confined*, the MPF defaults to *potential* (see Figure 12). This rating would be appropriate when the there is no evidence of movement from an unconfined source or when berms surrounding sources are old, eroding, or otherwise unmaintained.

To apply the *confined* MPF to a site requires information that transport of contaminated surface soil from the site to a point of exposure is restricted. Reasons to believe such confinement exists include the presence of site barriers such as buildings, maintained berms, and pavement or caps that prevent contact with the contaminated soil or prevent the contaminated soil from moving to a point of exposure. When conducting relative risk site evaluations for soils, take into account remedies implemented to contain or confine soil contamination.

Receptor Factor (RF). Soil receptors include only those humans with the potential to come into contact with contaminated surface soils, including residents, persons attending school or daycare on the site or in proximity to the site, and workers who have direct access to soil contamination on a frequent long-term basis.

The RF can be *identified*, *potential*, or *limited* (see Figure 6 for definitions). The RF is *identified* if analytical data or direct observation indicates that people reside or frequently work, recreate, or attend school or daycare in the area of contamination. If there are no workplaces, residences, schools, or daycare centers in the area of contamination, but access is not restricted, the RF is *potential* (see Figure 12).

Evaluate the RF as *limited* when it is unlikely that humans will come into contact with the contaminated soil. This would be appropriate when the MPF is *confined.*

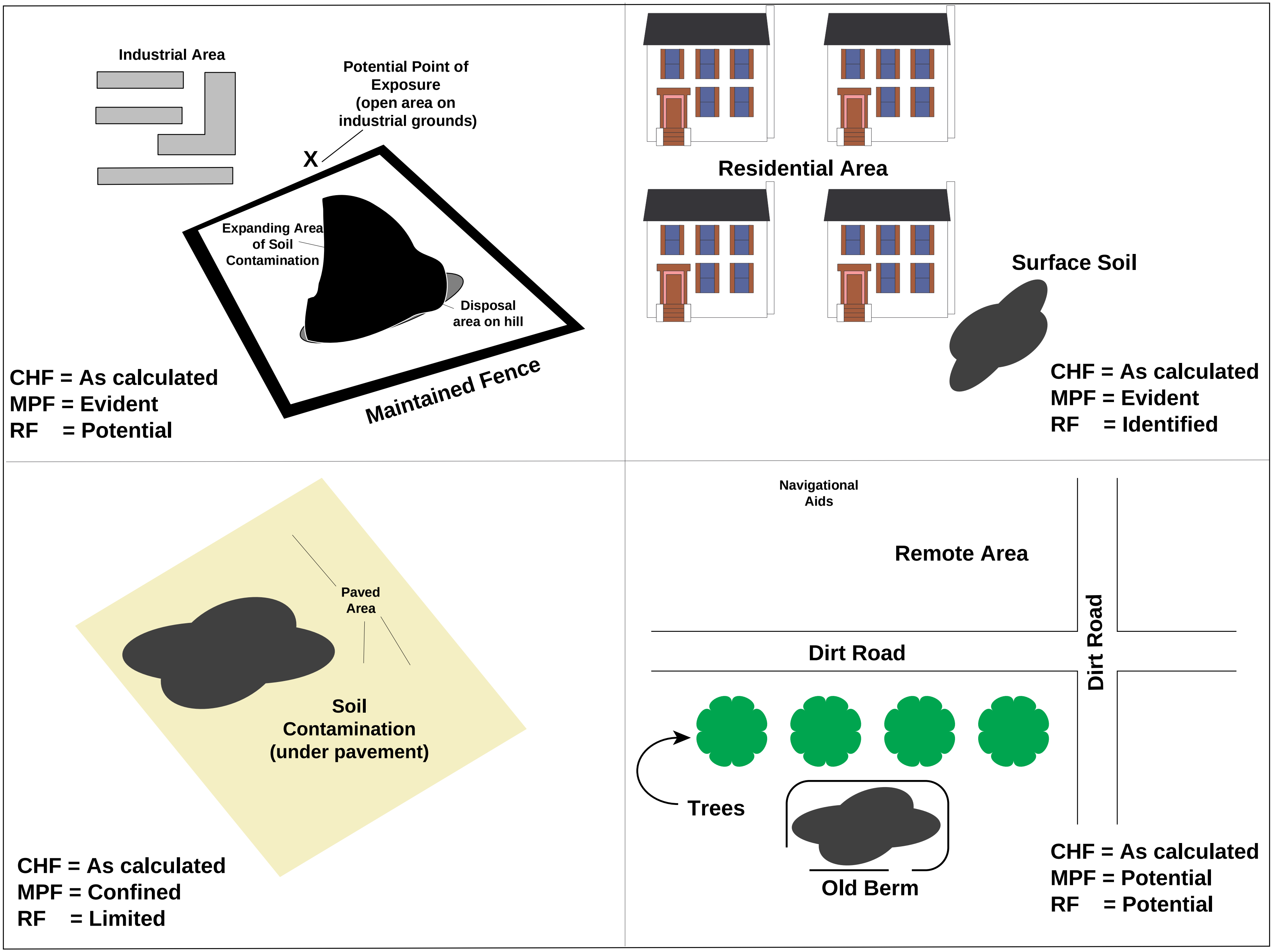

Figure 12. Example Scenarios for the Soil Medium

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